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AMERICAN METEOROLOGICAL JOURNAL.

A Monthly Review of Meteorology, Medical Climatology, and Geography.

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THE AMERICAN
METEOROLOGICAL JOURNAL.

VOL. IV. ANN ARBOR, DECEMBER, 1887. NO. 8.

CURRENT NOTES.

AN OCTOBER AURORA.—The observer of the Minnesota State Weather Service, at Duluth, (presumably Mr. E. R. Brace), gives the following description of the aurora observed at Duluth on the 21st: An aurora was first observed at 11:15 P. M., and consisted of a diffused white light extending high into the heavens; at 12:20 A. M. a perfect arch was formed having a dark segment below, through which stars were plainly visible; numerous beams, some nearly reaching the zenith at times, played upon the arch with a quick lateral motion. Height of arch 26°. No colors were observed other than a whitish or pale green light. The display continued after 1 A. M.

A REMARKABLE EXHIBITION OF ST. ELMO'S FIRE.—A remarkable exhibition of St. Elmo's fire was recently witnessed by the writer on the summit of the Sonnblick mountain in Austria, about 10,000 feet above sea-level.

The synoptic weather chart for September 9 shows that there was at the time a ridge of high pressure over Central Europe, with light and variable winds at the low-level stations. On the Sonnblick it had rained all day, with a southwest to a southerly gale. The pressure, which was high (nearly 20.7 inches, the normal being about 20.3 inches), was falling irregularly, and the temperature was about 37° F. About 6 P. M., with a sudden shift of the wind to the north, the pressure rose and the temperature fell to 30° F., causing the rain to change to sleet and snow.

About this time brushes of violet light were noticed outside the observatory upon the points of the lightning-rod, the anemometer cups, etc., and even upon projecting pieces of rock. From the heads of the observers and from their outstretched hands similar brushes of light streamed (resembling the positive discharge from an electric machine), accompanied by a crackling noise and a prickling sensation. This continued until the wind, which meanwhile had fallen to a calm, changed its direction to southwest and the pressure became stationary. The temperature soon rose above the freezing point, but the snow continued to fall for some hours. R.

MONEY EXPENDED ON THE MISSISSIPPI RIVER.—In the recent waterways convention held at Memphis, the reports of which we owe to Col. H. C. Bate, of Nashville, Judge R. S. Taylor, of the Mississippi River Commission, read the following figures, which may be of interest. They are the expenditures for the improvement of that river since 1881:

Appropriation to date	$9,950,000
Expended for:	
Plant	$1,500,000
Levees	2,600,000
Contraction	2,400,000
Revetment	2,300,000
Other work	200,000
Care of work	300,000
Balances	550,000
Total	$9,950,000
Gross State and individual expenditures for levees since 1882,	$4,350,000

BEHM'S GEOGRAPHISCHES JAHRBUCH for 1887 contains much matter of interest to meteorologists. The first 74 pages are devoted to an abstract of advances in geographical meteorology, and is from the competent pen of Dr. Hann. Like Professor Abbe's abstracts of meteorological progress in the annual reports of the Smithsonian Institution, it serves the twofold purpose of being a key to the recent literature on the subject, and, at the same time, a critical review at the hands of a competent critic. The

remaining articles treat of the advances in geophysics (quite different from physical geography), of the geognostic structure of the earth's crust, of oceanography, of the distribution of plants and animals, and of anthropology.

EARTHQUAKE-PROOF ARCHITECTURE.—In the course of remodelling that Japan is undergoing, the architecture of the western world is being introduced. The Japanese style of building, which has been evolved in the experience of many centuries, is especially adapted by its lightness and flexibility to withstand the earthquakes so numerous in that country, while the foreign buildings lack every earthquake-proof element. The advances in luxury and the domestic arts require the foreign architecture, however, and the question now arises of how to modify it for a region where earthquakes are frequent. So pressing has the question become that the government has invited several scientific bodies to appoint a joint committee to examine and report upon the best style of building to resist a shock of earthquake.

MINERAL SPRINGS IN TENNESSEE.—According to the *Bulletin* of the State board of health, Tennessee has fifty-seven mineral springs which are utilized as places of resort, a greater number than any other State of the Union. So far there have been two hundred and ninety mineral springs reported in the State. Only fourteen of this number have as yet been analyzed.

The waters of seven of these are used commercially, being barreled and bottled and shipped in large quantities. A number of these springs have locally quite a high therapeutic value accorded them, in affording relief in rheumatism and gout, and in certain forms of kidney, bladder, stomach, liver and intestinal disorder.

What is wanted is fuller and more accurate information regarding the mineral springs of the State, especially their clinical value and chemical composition.

SUPPORT OF BIRDS ON THE WING.—Professor W. P. Trowbridge read an interesting paper on this subject, at the last

meeting of the National Academy, of which we take the following report from *Science:* It has always been a puzzle how the muscular action necessary to keep birds on the wing so long as they often remain could be possible; and Professor Trowbridge explained the recent discovery by his son, which is, that birds of prey and some others have the power to lock securely together those parts of the wing holding the extended feathers, and corresponding to the fingers of the human hand. The action of the air on the wing in this condition extends the elbow, which is prevented from opening too far by a cartilage, and the wings may keep this position for an indefinite length of time, with no muscular action whatever on the part of the bird. While resting in this way, the bird cannot rise in a still atmosphere; but, if there be a horizontal current, it may allow itself to be carried along by it, with a slight tendency downward, and so gain a momentum by which, with a slight change of direction, it may rise to some extent, still without muscular action of the wings. The Professor also believed it quite possible for a bird to sleep on the wing. In discussing this paper, Prof. J. S. Newberry said that he had once shot a bird which came slowly to the ground as if still flying, but reached it dead. He believed that it had died high in the air; but he had never been able to account for the manner of its descent till now, when he found an explanation in the statement of Professor Trowbridge.

PRESERVATIVE EFFECTS OF SEA-BEACHES.—Mr. John R. Smith, of the Cape Cod light station, sends us a remarkable illustration of the preservative effects of the sand of a sea-beach. It is a piece of oak from an old wreck uncovered by a recent heavy storm. The oak is, apparently, as sound as when it was shaped by the ship-carpenters. Mr. Smith gives the history of the ship as follows:

"It is a piece of wood from the British man-of-war Somerset, and is from the date of the laying of the keel to the present time, 141 years, four months, and twenty days old. A few items from her history are as follows: She was a third rate ship of sixty-four guns. Her keel was laid in Chatham, England, May 5, 1746.

She was launched July 10, 1748, and left England October, 1774, for North America. She returned in 1776. She left England for the last time March, 1777, and was wrecked at Peaked Hill, Provincetown, Mass., Nov. 2 or 3, 1778. This information comes from Evan Macgregor, Secretary of the Admiralty, Whitehall, London, with date of May 28, 1886. Since her wreckage she has, for a period of over 100 years, been buried beneath the sands of the beach, and the condition shows the remarkable preserving powers of sea-sand. The same wood, if not buried beneath the sand but immersed in the water alone, would long ago have been rotted and worm-eaten. By some freak of recent gales her ribs have been laid bare, and are fast disappearing under the energy of relic seekers. She is spoken of by Longfellow as lying at her moorings in Boston Bay, Mass., on the night of Paul Revere's memorable ride. At the battle of Bunker Hill she stormed the fortification in the early morning, and afterwards covered the landing of the red-coats. After she was wrecked by a storm,—and at which time many of her men were lost,—her guns were utilized in the fortification of Gloucester and on the coast of Maine. The wreck is easily identified by the ponderous timbers, thick plank and port-holes, and the piece I send you was taken from her by my own hands."

Thermographs Wanted for Marine Observations.—In a paper read before the Royal Meteorological Society last March, Dr. H. R. Mill calls attention to the pressing need of a thermograph which will register changes of temperature as the instrument passes slowly from the surface to the bottom of any body of water of which the temperature is to be investigated, and, in the discussion which followed, Capt. Wilson-Barker reiterated the want. The simple problem of getting temperatures at definite depths is not an altogether easy one, but it has been solved, and the instruments now in use for this purpose are fairly satisfactory. What is needed is a continuous record, and this can probably be made only by electrical instruments.

The results of observations as now made have proved to be of great interest and importance. The thermometer has not only

revealed many facts concerning the mutual heat transactions of air and water; it has also been converted into an instrument of hydrographical research, the most conspicuous example being the discovery by it of the Wyville-Thomson Ridge in the Färoe Channel. The thermometer can be used to warn navigators of their approach to icebergs, to land, or to certain currents, and it aids materially in tracing out the interactions of river and sea water in harbors and estuaries. Undoubtedly marine life is greatly influenced by temperature, and the thermometer may be expected to play an important part in the management of fisheries.

The inventor who would devise a satisfactory thermograph would confer a great boon on this branch of science, but the task is not an easy one. The instrument must record slight differences in temperature, but it must also be capable of registering at any depth, must be capable of withstanding the high pressure of great depths, must be indifferent to long soakings in salt or fresh water, must be capable of withstanding all the jerks and rough treatment it would get in a heavy sea, and must at the same time make its record accurately and instantly. It should record with the temperature the pressure or depth, perhaps preferably the former, as with specific gravity and pressure the depth could be easily deduced.

Fog Predictions.—This very important branch of predictive meteorology is being studied by Sergeant Garriott, of the Signal Corps, with promise of good success. In a recent number of the *Monthly Weather Review*, he says:

"The atmospheric conditions requisite to the development of fog are too well known to require discussion; suffice it to say that these conditions are more marked and more frequently exist over the Banks of Newfoundland than in any other locality within the usual routes of travel. The prevailing winds in this region are westerly, and the differences in temperature between air drawn from the continent and that which overlies the ice-fields and the cold Arctic currents are not, as a rule, sufficiently great to cause a large precipitation of fog-atoms. It is therefore evident that the denser fog formations are due to meteorological conditions, whereby greater ranges in air temperatures are occa-

sioned. The element of cold air is constant in this region and the opposing element of warm air is ever present over the ocean to the southward and over the Gulf Stream, which flows from the southwestward over the southern edge of the Banks. The causes which influence the flow of warm air from the southward and from over the Gulf Stream are necessarily due to meteorological conditions, whereby the prevailing westerly winds are diverted to the southern or eastern quadrants. The causes whereby these conditions are developed are traceable to cyclonic areas which pass eastward over the ocean from the continent. All reports of fog encountered in the vicinity of the Banks verify these conclusions, and it now remains to determine how this knowledge can best be utilized for the benefit of shipmasters.

"For purposes of fog predictions it is advisable to consider only the storms which leave the American coast north of the thirty-fifth parallel, both by reason of the fact that they generally pass over, or in close proximity to, the Banks of Newfoundland, and on account of the facilities offered by telegraphic land reports for foreseeing their probable course from the interior or western portion of the continent. Following the appearance of a storm-area in the central valleys of North America, a minimum period of about three days is commonly allowed for its advance to the Maritime Provinces, at the expiration of which time the conditions favorable for fog would commence to develop over the Banks, and would continue about two days, or until the passage of the depression had caused the wind to again shift to westerly. This calculation allows a period of at least five days between the appearance of a cyclonic area over the interior of the continent and the time of greatest probable fog density over the Banks as resulting from its eastward movement. With this margin of time allowed, forecasts of great interest and value could be made for the benefit of the shipping interests. Outward bound steamers could be forewarned of the probable presence of fog over the Banks in season to anticipate its presence on arrival in that locality, and vessels about to sail from British ports could have seasonable warning by cable. In cases of abnormal and unexpected rates of progression of storm-areas, or of rates of speed, on the part of vessels, insufficient to reach these longitudes in the time prescribed, a knowledge by shipmasters of the laws governing the circulation of winds within areas of low barometric pressure, and of the fact that with a shift of wind to the northwest quadrant, following the passage of a storm-centre, the fog-banks would dissipate, would enable them to determine, upon approaching the Banks, whether the anticipated conditions had developed or disappeared. If easterly or southerly winds and falling barometer were noted, it would indicate that the centre of the low barometric area was still to the westward, and fog might be expected; if, on the contrary, the wind had commenced to shift to westerly with steadily rising

barometer, it would show that the storm-centre had passed to the eastward of the Banks, and an early disappearance of fog in that region might be calculated upon.

"This subject is of vital importance to shipmasters, and will be pursued, not only in connection with the fogs peculiar to the Banks of Newfoundland, but also as relates to those which develop along the American coast in more southern latitudes."

ROYAL METEOROLOGICAL SOCIETY.—The opening meeting of this society for the present session was held on Wednesday evening, the 16th of November, at the Institution of Civil Engineers, 25 Great George Street, Southwest, Mr. W. Ellis, F. R. A. S., President, in the chair.

Mr. C. E. de Bertodano, Dr. W. A. Bowen, Mr. F. J. Brodie, Dr. F. B. Hyslop, Prof. H. H. McMinnies, and Capt. T. C. Newton, were elected Fellows of the Society.

The following papers were read:

(1) "The Use of the Spectroscope as a Hygrometer simplified and explained," by Mr. F. W. Cory, M. R. C. S., F. R. Met. Soc. The object of this paper is to suggest as simple a way as possible of using the spectroscope as a hygrometer in order to facilitate its introduction amongst observers as a standard meteorological instrument. The best form of hygrospectroscope as a recognized standard for the purpose of investigating and scrutinizing the changes of the three parts of the spectrum mentioned is that originally termed by Mr. Rand Capron, "The Rainband Spectroscope." It ought to have a fixed slit, and in addition a milled wheel at the side for the easier adjustment of the focus. The author concludes by giving a set of hints to observers for taking weather observations with a pocket spec troscope.

(2) "Rainfall on and around Table Mountain, Capetown, Cape Colony," by Mr. J. G. Gamble, M. A., M. Inst. C. E., F. R. Met. Soc. The author calls attention to the great and in some respects peculiar differences that exist between the quantity of rain that is registered on and around Table Mountain. The most striking feature is the small fall on the signal hill. The signal hill, otherwise called "the Lion's Rump," lies to the

west of Capetown, between it and the Atlantic. The average annual fall there is only 15 ins., while the fall at the western foot is 21 ins., and in Capetown 27 ins. The signal hill is 1,143 feet above the sea. The fall at Platteklip, on the northern slope of Table Mountain, overlooking Capetown and 550 feet above the sea, is considerable, namely, 45 ins. The greatest fall is at Waai Kopje, about half a mile to the southward of the highest point of the mountain, at an elevation of 3,100 feet, or 450 feet below the top. Another station on Table Mountain, further south, that is, to the leeward in the rainy reason, and 2,500 feet above sea level, has only 39 ins. The eastern suburbs, Rondebosch, Newlands and Wynberg, all have a comparatively abundant rain-fall, 40 to 50 ins. and upwards, the greater part of which falls in winter time.

(3) "On the cause of the Diurnal Oscillation of the Barometer," by Mr. L. Lawson, LL. D. The object of this paper is to show that the diurnal oscillation of the barometer is mainly due to the combination of the earth's rotation with its orbital motion.

Sky-glows and Krakatoa.—"The beautiful sky colors of the autumn of 1883 are still vividly in the minds of many," writes an esteemed correspondent to us, "and there occasionally appear papers on the subject even to this day. I send you, therefore, an article from a daily newspaper which you may, perhaps, think wise to put into more permanent form." The article in question bears the title of The Volcanic Dust Theory, and is as follows:

In the English Journal, *Nature*, there appeared on the 26th of May quite a long discussion by Hon. Ralph Abercromby, on the connection between Krakatoa dust and these sky colorings. Mr. Abercromby asserts that in two voyages "around the world" he observed the movements of the upper clouds very carefully in the equatorial regions and found it very difficult indeed, except at rare intervals, to note any motion at all. Leaving out of the account the difficulty one would have in observing such motions while traveling or at sea (I mean while in motion), still this point is very significant. I think that views in regard to

upper-current movements and velocities are becoming very much modified as observations increase. Instead of the uniform directions and great continuous movements, once regarded satisfactory, we now find that these motions are almost as dependent on the movements of high and low areas of pressure as are the surface winds. In the United States (middle latitudes), if a great and extensive high area is over a place or to the eastward, the very highest cirrus are either stationary or have a slow motion to the west. On Mt. Washington, N. H., 6,300 feet above sea-level, when a high area is over the station, or within 100 miles on either side, the mean wind velocity is twenty-one miles per hour, but when a low area is near or over the summit the mean velocity is over fifty-three miles per hour. This will help us in understanding the enormous velocities of cirrus (over 100 miles per hour) noted a few times by Mr. Hildebrandsson in Upsala. Sometimes, with a low area near, the wind reaches 150 miles per hour on Mount Washington, and once it reached 200 miles. Upsala is 600 miles farther north than Mount Washington, and as we go north, up to a certain latitude, the upper currents increase in velocity. It is very plain that a velocity much greater than 100 miles per hour might occur in cirrus clouds in front or rear of a storm at Upsala, but this is not the average velocity, nor would it continue more than a few hundred miles in any direction. Can anything whatever be inferred from all this as to velocities or motions near the equator? I think most emphatically no. We are, however, by no means ignorant of motions of upper clouds in the equatorial regions. The following are the facts, first as to direction and second as to velocity: Observation of upper clouds have been carefully made in these portions of the earth at various points. The earliest and most satisfactory collection of these that I have found is in Coffin's "Winds of the Globe." In this work, with a few exceptions, the directions is from the east, or from a point north of east, at places north of the equator. In "Meteorology of India," published by Blanford, I find the average direction of the wind in August and September at high stations near the equator as follows: Wellington, latitude 10 N., height 6,200 feet, about seven years' re-

cords, wind from N. 83 W., velocity 5 miles per hour; at Newera Edya, latitude 7 N., height about 6,150 feet, records for twelve years, N. 60 W., velocity 4 miles per hour.

A brief study of the observations of upper clouds, as reported to the United States from international meteorological stations near the equator, has shown nearly a uniform direction (from the east), though, at times, there are most remarkable exceptions, which I hope to present more fully in another place. A most important consideration is the height of these clouds. I believe no careful measurement has ever been made, but from various considerations I would place the superior limit at 15,000 feet, though I think they rarely reach 10,000.

As to directions above this height (15,000 feet) we must consider the motions of volcanic ashes that have been traced to their source, as well as dust that has been carried thousands of miles. The evidence, up to August 27, 1883, is all one way, and that is that the extreme-upper current moves from west to east. I believe that no one who will carefully sift the facts as observed can come to any other conclusion.

When we come to study the velocities of these currents, we are struck forcibly by this one fact, that they are exceedingly slow or none at all, and this is precisely what Mr. Abercromby observed. On the mountain stations in India above noted the mean velocity is 4.5 miles per hour at 6,000 feet. I have no data for the maximum velocity, but very much doubt if it ever reaches thirty miles per hour, and whatever it is it certainly is not from the east. In studying the motions of the upper clouds as reported to the "international bulletin," one immediately recognizes the extreme slowness of movement. Repeatedly the record is made "calm" when clouds are abundant. I find at Havana, Cuba, latitude 23 degrees, out of 103 observations of high clouds, forty-one were "calm," and at Kingston, Jamaica, latitude 18 degrees, out of 118 records of cirrus fifty-seven were calm.

It seems to me the evidence is overwhelming that near the equator the surface trades have almost constant and relatively great velocity from an easterly point; that this velocity gradually diminishes as we rise in the atmosphere till it becomes

zero at 20,000 to 30,000 feet, and after that point is reached the currents begin to have a tendency in the opposite direction. This evidence was so convincing to Prof. Kiessling, of Germany (who probably has paid more attention to this subject than any one else), that he was forced to abandon the view that upper currents had anything to do with the first distribution of Krakatoa ashes, and sought relief in the theory that the ashes were carried above the earth's attraction, and above the region of atmospheric friction so far, that they remained suspended as a cloud, while the earth rotated from west to east underneath them. This is very ingenious, and, it must be confessed, would account for many of the facts, provided certain assumptions be made. I hardly think, however, that any physicist of repute will agree with Prof. Kiessling. Whatever caused the glows, I am sure every one who will look into the question in the light of our knowledge of the upper currents, will admit it could not have been Krakatoa ashes mechanically distributed. It seems to me the animated discussion so far carried on can but add very materially to the science of meteorology, though it may seem that a final solution of the question may not be reached till our appliances for and methods of observing nature's laws and forces have been extended far beyond thair present scope. Mr. Abercromby has submitted that the upper currents, over the West India Islands, are from the west, but he still thinks this is not the case over mid-ocean. As the original glows nearly covered the whole earth, it will be seen that the upper currents must be continuous from east to west over the globe, and any departure from this would be fatal to the original hypothesis.

TYPHOID FEVER IN MICHIGAN AND THE DROUTH.—Owing to the greatly diminished rain-fall during the spring and summer of 1887 and the consequent lowering of the water in streams, ponds, and wells, a marked increase in the prevalence of typhoid fever was feared, and unusual efforts were put forth by the office of the State Board of Health, from the abstract of whose proceedings we derive this note, for the prevention and restriction of the disease. The increase did not take place quite as early

as expected, but an examination of the following tables will afford a useful means of comparison between the sickness from typhoid fever by months in 1887, with that of 1886, 1885, and the average for the nine years, 1878–1886. The rain-fall for the same periods of time is also shown. The changes in the level of the ground water for the first nine months of 1887 and by months for the two preceding years are also shown.

Average per cent. of reports stating the presence of Typhoid Fever by Months in the Nine Years, 1878–86, also by Months in 1885 and 1886, and for the first Nine Months in 1887.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Av. 9 yrs. '78–86	11	9	7	6	5	6	7	13	20	22	20	15
1885	11	7	5	4	3	5	5	6	11	13	16	8
1886	6	3	4	3	5	4	5	13	16	16	13	10
1887	8	9	7	3	3	5	6	14	23	.....	.....	.....

Rain-fall in Michigan.—Average number of Inches, by Months, for the Nine Years, 1878–86, also in 1885 and 1886, and for the first Nine Months of 1887.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Av. 9 yrs. '78–87	2.07	2.72	2.40	2.59	3.66	4.41	3.55	3.34	3.82	3.56	3.08	2.71
1885	2.70	.73	.58	2.47	2.30	6.01	2.52	5.82	3.75	3.08	2.90	2.14
1886	3.05	1.72	2.74	2.40	2.58	2.29	1.36	4.21	5.36	1.97	2.35	2.13
1887	2.27	4.47	1.18	1.54	2.25	2.76	2.46	1.98	3.12	.....	.....	.....

By comparing the per cent. of reports of the presence of typhoid fever in Michigan in the third quarter of 1887, with the average of the third quarter in the nine years, 1878–1886, there is shown to be an increase of three per cent. in the reports for 1887. By comparing the per cent. of reports in the third quarter of 1887, with the third quarter of 1886, an increase of nine per cent. appears, and when compared with the third quarter of 1885, there is shown the marked increase of twenty-one per cent.

The rain-fall for the third quarter of 1887 has been 3.15 inches less than for the corresponding third quarter in the nine years, 1878–1886, 3.37 inches less than in 1886, and 4.53 inches less than in 1885. If we add the month of June to the quarter for the purpose of comparison of rain-fall, that of 1887 is 4.80 inches less than the average for the nine years, 2.90 inches less than

that of the corresponding months in 1886, and 7.78 inches less than the corresponding months in 1885.

Ground-Water.—Inches of Earth above the Water—Average by Months for the Two Years, and for each of the Two Years, 1885-86, and for the first Nine Months in 1887, at Two Stations in Michigan.

Period of Time.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Av. 2 yrs. '85-86	244	244	241	234	235	237	240	245	243	245	247	248
1885	249	250	246	236	238	239	242	241	238	241	241	240
1886	239	237	235	232	231	234	238	248	248	249	253	255
1887	250	248	243	244	249	248	257	254	256	.....	.....	.....

The evidence in this table relative to ground water has not as extensive a base as is desired, but it is given as the best available and for what it is worth. The number of wells is only two, but the measurements are believed to be accurate, and the wells are near the centre of the State, one of them at Lansing, being distant from any other well, and no water being drawn from it, it is believed to be especially useful as indicating the changes in the level of the ground water.

In studying the table, the fact must be held in mind that the water is lowest when the figures in the table showing the "inches of earth above the water" are greatest.

It may be seen that the water in wells was lower in the early part of 1885 than in the early part of 1886, and that the typhoid fever was more prevalent in the early part of 1885 than in the corresponding months of 1886. The water in wells for the early months of 1887, is shown to be lower than in those months in 1886, and typhoid fever is shown to be more prevalent in the early part of 1887 than in the early part of 1886. In the third quarter of 1887 there is shown a lowering of the water in wells, compared with that in the corresponding quarter of 1885 and 1886, and there is shown an increase of typhoid fever in the third quarter of 1887, compared with the third quarter of 1885 and 1886.

NOTES FROM THE PILOT CHART FOR NOVEMBER.—*The Westerly Drift in the Region of the N. E. Trades.*—Lieutenant W. F. Low, U. S. N., reports a notable easterly current in the N. E.

trade region during September, where a decided westerly drift is generally experienced. The observations were made on board the U. S. T. S. "Saratoga," during a voyage from Madeira to New York. September 4–10, middle latitude about 23° 30′ N., longitude 34° to 48° W., easterly and southeasterly currents of from 7 to 21 miles a day were experienced. On September 11 this easterly set was lost, and the usual drift (W. N. W., 18 miles) was noted. The trades were fresh, with no unusual meteorological conditions. Commander C. H. Davis, U. S. N., states that there can be no doubt as to the accuracy of these observations, as the three ships of the training squadron were cruising in company, and the navigator of each vessel observed the same easterly set during this interval.

These observations are very interesting because a westerly drift has been almost invariably reported throughout the trade region. The "Challenger," for instance, during her voyage from Madeira to Sombrero, in February and March, 1873, followed a track very near, but a little to the southward of that of the "Saratoga," and no easterly currents were observed. Probably these, with other reliable observations during September, may indicate some important general change during that month, possibly due in part to the effect of the August hurricanes in increasing the volume of the great equatorial current flowing to the westward in lower latitudes.

Northers in the Gulf of Mexico.—During November the "nortes," or northers, become established, and occur occasionally all winter. In the earlier months of the season they are of frequent occurrence and long duration, attaining full strength in a few hours, and often lasting two days or more. Later on they occur less frequently and are of shorter duration, but of somewhat greater violence. The usual indications are a steady wind from the south, with clear atmosphere in that direction, but with a peculiar haze towards the north, falling barometer, and warm, moist, oppressive atmosphere, with a heavy cloud bank, and lightning to the northward. Soon the wind shifts in a heavy rain squall, and the gale sets in from the northward, with cold and sometimes clear weather.

Submarine Earthquake in the Windward Channel, West Indies.—On September 23, at about 7 A. M., several shocks of earthquake were experienced by three vessels off the eastern coast of Cuba. The positions of these vessels were within a circle about 250 miles in diameter, and their reports, which are given herewith, seem to indicate that the shock was central near Cape Maysi, Cuba. The intensity of the earthquake might be roughly estimated as about 8 or 9, on the Rossi-Forel scale (0 to 10), and it was probably felt in eastern Cuba, western Santo Domingo, Inagua, and possibly Jamaica, an area in all of perhaps 200,000 square miles. In reporting such an occurrence, one of the most important observations is the correct time (to the nearest second, and referred to some standard meridian) of the commencement and duration of each shock. When this is given by several vessels, and the position of each at the time is stated, an idea can be obtained as to the probable position of the center of disturbance and the velocity with which the shock travels.

Captain Armstrong, British steamship "Alps," reports: September 23, 7 A. M., off the south coast of Cuba, latitude 19° 44′ N., longitude 74° 24′ W., felt the shock of a submarine earthquake lasting about 45 seconds, causing the ship to vibrate fore and aft. When 7 miles farther N. E. by N., felt another milder shock, lasting about 7 seconds. At 8:10 A. M., 13 miles distant from 7 A. M. position, felt three shocks, each lasting about two-thirds of a second, at intervals of about 1 second. At 8:45 A. M., felt another mild shock, lasting about 2 seconds. The sea was quite smooth. When the first shock was felt the sea appeared to rise higher in a solid body (without the least break) for about 3 seconds, and continued smooth after. Barometer 30.05, temperperature of air 79°, water 84°. By the charts, I should think the disturbance occurred in more than 1,000 fathoms of water.

Captain Slocomb, British bark "Tamora," reports: Violent earthquake shock felt on the 23d of September. Latitude 21° 01′ N., longitude 74° 50′ W.; three distinct shocks within an hour. The first and most violent occurred at 7 A. M. and lasted 15 seconds. The vessel jumped as if she had struck bottom

shaking the yards and masts violently. The last two shocks were of about 5 seconds' duration, and less violent.

Captain J. Marquez, Spanish steamship "San Francisco," reports: "September 22 to 23, 19 hours and 15 minutes (September 23, 7:15 A. M.), experienced an earthquake. Three or four shocks, causing a sensation as though the ship were bumping on a rock. Vessel was 20 miles from land, off northern coast of Cuba; voyage from Puerto Rico to Havana. Noon position, September 22, latitude 20° 31′ N., longitude 67° 59′ W. from San Fernando (74° 11′ W. from Greenwich); September 23, 22° 31′ N., 71° 58′ W. (78° 10′ W. from Greenwich).

Discolored Water.—Captain Green, British ship "Erato," reports that on July 28, latitude 6° 24′ N., longitude 53° 34′ W., the water was perfectly black, and when broken by the ship it appeared to be a very dark green. Barometer 30.12. Thermometer at noon 84°; midnight 83°. Wind S. S. E., force 6. Current N. 69° W., 1½ knots per hour.

Patches of discolored water are often observed at sea in positions where the depth is known to be so great as to preclude any idea of there being shoal water. Very often such discolorations are due to masses of floating sea-weed, the well known gulf weed, for instance, but here the cause is very evident, except at a distance. In other cases dense swarms of minute organisms, foraminifera or medusæ, are the cause, and whales are often seen feeding on them. Another cause sometimes assigned is that ejections of mud from submarine volcanoes, or clouds of sediment stirred up from the sea bottom by submarine earthquakes, reach the surface. Finally, it is well known that alluvial sediment is brought down by rivers and carried out to sea, where it is sometimes taken up by ocean currents and transported great distances.

To the eastward of the Windward islands such reports were formerly so common as to give rise to the idea that there was shoal water, but since careful soundings have proved the contrary, it has been thought that the discolorations were due to submarine volcanic action along a line of disturbance approximately parallel to, and to the eastward of, the Windward islands.

Along the northeastern coast of South America, sediment from the rivers along the coast is probably the cause in most cases, the Amazon and Orinoco especially bringing it down in vast quantities, and the northwesterly current transporting it along the coast.

If a small bottle full of the water could be brought in, its examination might aid materially in determining the exact cause of the discoloration in each particular case.

BOLETIN DE LA ACADEMIA NACIONAL DE CIENCIAS EN CORDOBA. Oct., 1886. Tomo IX. Entrega 3a, pp. 229–348.—In this part of the Bulletin of the National Academy of Sciences of the Argentine Republic, we find the pages 230-300 occupied by Dr. Doering's paper giving the meteorological observations at Cordoba for the year 1885. The different elements are grouped by themselves and not according to the international form. The readings are given for tri-daily observations at 7, 2, 9, and the means are given for the ten day periods of each month, as well as the total for each month.

There is given pressure; temperature; vapor tension; relative humidity; evaporation; soil temperatures at surface and depths of 7.5, 15, 36, 66, and 126 centimeters; irradiation at 2 P. M.; monthly means of the elements mentioned, and cloudiness, precipitation and relative frequency of winds.

The pages 301–348 contain a paper in French on the "Influence of low temperatures on vegetation in general and the Eucalyptus in particular," by Dr. Moïse Bertoni Deblanchis.

In the preface, § I, the author refers to the gradual spreading of the Eucalyptus and the destructive effects of the cold of ordinary European winters.

§ II gives the author's early experiments in the Swiss Alps from 1876 to 1881, in the last year of which he used 838 individuals of 32 species, among which he found several more hardy than the Globulus. He gives the meteorological conditions of the regions and especially the temperatures.

§ III contains "researches on the action of low temperatures on vegetation," taking into account the humidity as well, and

bringing out the fact that the "vegetation temperature" is different from the air temperature. He describes a "*thermographe végétal*," "which consists of a good mercurial minimum thermometer having its bulb enveloped in a piece of muslin, which latter dips into a small vessel of pure water; and it is necessary that the thermometer be bent at right angles so that the part enveloped by the muslin will be vertical; if this precaution is forgotten the thermometer will risk being broken by the congealing of the water."

Then follows a description of the requirements concerning the thermometer and its exposure, the most important of which are that the muslin must be green in color, and the thermometer must have a free exposure at a height of a meter and a half above the ground.

Such a thermometer reads several degrees lower than the minimum of the observatory, as is shown by the following table:

Date.	Observatory Minimum.	Thermographe végétal.
	°	
1882, Nov. 16	—1.4 C.	— 3.1 C.
" 19	—2.8	— 4.8
" 20	—3.9	— 4.8
Dec. 1	—3.5	— 5.4
" 2	—2.5	— 6.5
" 3	—5.4	— 8.6
" 5	—5.0	— 5.8
1883, Jan. 23	—8.6	—10.8

§ IV. "Phenomena which exercise an influence on the Resistance of Vegetation."

For instance, the capability of resisting the cold increases with the age of the plant, but, on the contrary, the aqueousness decreases this resistance. The solar radiation, system of planting, place of planting (exposure), etc., all enter into question of determining the limit of resistance of vegetation.

§ V. The author gives here a list of 89 species with the temperatures at which the plants can live (*thermographe végétal* and minimum thermometer in shelter), and the limits of accli-

matibility as regards latitude and altitude above the sea level at the lat. 34° 31′.

§ VI. Contains tables of the increase of resistance by age.

§ VII. Note on "Le Pinçage." This is perhaps the "pinching back" practiced by our own horticulturists.

§ VIII. This section contains a resume of the means of increasing the resistance of the Eucalyptus to low temperatures.

§ IX. Manner of determining the true minimum temperature of a place with reference to acclimatization.

§ X. "Action of the Humidity of the Ground."

§ XI. "Rapidity of Growth." Here we find a table giving the height of the various (78) species in centimeters, when the plants have attained the age of seven months.

While such papers as Dr. De Blanquis' are at present of more interest to botanists than to our meteorologists, it is to be hoped that the latter will, in the near future, give more attention to the meteorological conditions affecting plant life as well as animal life. F. W.

METEOROLOGICAL OBSERVATIONS DURING THE SOLAR ECLIPSE OF AUGUST 19, 1887, MADE AT CHLAMOSTINO, RUSSIA.

Meteorological observations made during total eclipses of the sun are not easy of interpretation. The fluctuations noted may be due to the eclipse itself, or to other conditions prevailing at the time, and it is not possible in all cases to decide upon the true cause or causes of the observed effects. A fall in temperature and a rise in humidity, which are obviously to be expected when the sun's heat is temporarily cut off, are always observed, though in varying degree; but the fluctuations in the air pressure and in the direction and velocity of the wind have not yet been definitely determined. On account of their minuteness, they are concealed by the greater fluctuations assignable to other causes. The shadow path of the eclipse of August 19th, extending through Prussia, Russia, northern China and Japan, was not favorably situated for the study of minute fluctuations, as the non-periodic disturbances of the atmosphere in

the region traversed are large, but in the two countries first named meteorological stations are quite numerous. It was, therefore, thought possible that by co-operation on a uniform plan, results of interest might be obtained by combining the records of the different stations, even if little could be learned from those at any one station. The meteorological services of Prussia and Russia accordingly issued a circular to their respective observers and prepared special blank forms for the records desired. The plan adopted differed somewhat, but not materially; in Prussia the observations were made every five minutes for one and one-half hours immediately preceding and following the time of greatest obscuration, while in Russia they were made every ten minutes for four and one-half hours, at designated minutes of Greenwich time, besides at other times on the day of the eclipse and on the preceding and following days, for purposes of comparison. Observations were also made at several stations in Japan. The observations were the usual observations of pressure, wind, temperature, etc., made according to the rules of the separate services co-operating. Requests were also made for observations at the special stations within the shadow line established for astronomical or other purposes. At one of the latter, a special series of meteorological observations was planned, including those called for by the plan of co-operation, but adding others. It is the object of this paper to describe the work attempted at this station, to give the observations in detail and the results obtained.

Station.—The place selected for the station, Chlamostino, is a small hamlet about three miles northeast of the large manufacturing town of Iwanowo, and about 160 miles northeast of Moscow. According to the best maps available, the geographical position is lat. 57° 0′, long. 41° 3′ E. of Greenwich.

Outfit.—The instrumental outfit consisted of the following:

Barograph, of the Richard Frères pattern, but specially constructed for these observations, with an open scale and with a drum revolving in four hours. The pressure scale is 2 millimetres for each millimetre of mercury, and the time scale about 4 millimetres for each $2\frac{1}{2}$ minutes.

Three aneroid barometers: (1) Hottinger 3241, of the Goldschmid pattern, graduated to 0.001 inch, and used for similar observations at Caroline Island in 1883; (2) Casella 2720, graduated to 0.01 inch; (3) Watkin aneroid 37, constructed by Hicks, graduated to 0.02 inch.

Psychrometer, consisting of two Fuess thermometers 146 *a* and *b*, graduated to 0.2° C.

Maximum thermometer, Fuess 878, graduated to 0.5° C.

Minimum thermometer, Casella 49417, spirit, with triple forked bulb, graduated to degrees C.

A pair of solar radiation conjugate thermometers of the Arago-Davy pattern, made by Fuess, graduated to 0.5° C.

Solar radiation thermometer, black bulb in vacuo, made by Bodien, graduated to degrees C.

Two Bodien thermometers, graduated to degrees C, one used to determine the temperature at the earth's surface, the other that of the room in which the barograph and two of the aneroids were located.

Anemometer, U. S. S. S. pattern, tested at the Deutsche Seewarte.

The psychrometer, maximum, minimum, and conjugate thermometers and the anemometer were furnished through the kindness of Prof. Neumayer, director of the Deutsche Seewarte; the Hottinger aneroid through the similar favor of Gen. A. W. Greely, Chief Signal Officer, U. S. A.

Location of Instruments.—The barograph, Watkin and Casella aneroids were placed upon a table in the log cabin serving for the station, 30 inches above the ground. The aneroids were kept in their cases, which were filled with cut paper and the lids closed except when read. The case of the barograph was enclosed in a second case, with the space within filled with cotton-wool and other packing material. The Hottinger aneroid was read at the anemometer station described below.

The psychrometer and maximum and minimum thermometers were hung from a string at right angles to the north side of the house. The bulbs of the former were about 3 ft. 4 in. above the grass, and those of the latter about 4 ft., and all were at least

10 inches from the side of the house. The thermometers were protected from possible sunshine in the early morning by an open door.

The anemometer was placed upon a pole at the summit of a slight elevation 680 feet distant from the house, bearing N. 50° E. from it. The location was in a ploughed field, with free exposure in all directions. The cups were 14 ft. 2 in. above the ground, and the dial was read from a ladder. At the top of the pole was placed a crossbar of wood, from which was suspended a piece of string with a bunch of wool at the free end. This served satisfactorily for a wind vane in the light wind which prevailed, the points of the compass having been marked upon the ground beneath.

Adjacent to this pole were placed the radiation and earth thermometers, the former upon posts with their bulbs 3 feet above the ground, the latter on the ground with its bulb covered with loose earth. Of the radiation thermometers, the two forming the Arago-Davy actinometer were placed nearly horizontal, the other vertical.

Personnel.—The party consisted of Prof. W. Köppen, of the Deutsche Seewarte, and the writers. According to the plan of work agreed upon, Prof. Köppen confined his attention to the clouds, noting especially the forms and direction of motion, and the changes in color at the time of totality; Mr. Rotch read the barometers and thermometers at the log cabin, and Mr. Upton the anemometer and other instruments at the anemometer station. The readings were made simultaneously, at a given signal.

Observations.—The schedule of observations was prepared according to the plan of the Russian meteorological service, which contemplated records on the day of the eclipse and on the day immediately preceding and following. On each of these three days observations began at 4:13 A. M., local time, and continued until 12:43 P. M., and were made at hourly intervals (except the first, which was a half-hour interval) on the 18th and 20th, and on the 19th at ten minute intervals between 5:43 and 10:13, and half-hour intervals for the remainder of the

time. These times were strictly followed with the addition of extra observations on the 19th, to make the interval but 5 minutes for the three hours 5:33–8:33, in which the eclipse occurred.

The calculated times for the eclipse at the station were as follows, assuming lat. 57° 0′, and long. 41° 5′ E.:

First contact,	6h.	4m.	8s.	local time.		
Second	"	7	1	33	"	"
Third	"	7	4	5	"	"
Fourth	"	8	5	19	"	"

Sunrise occurred at 4h. 36m., and at the time of the total phase the altitude of the sun was 19°, and its azimuth S. 84.5° E.

The sky was partially or wholly overcast on each of the three days of observation, and a few light showers occurred on the third day. On the second day, that of the eclipse, the sun was not seen until after the total phase, but was seen several times during the second partial phase.

The following tables give in detail the observations made, arranged for convenience in printing in three groups under each day. The columns are in general self-explaining, but comments may be necessary on several points.

The aneroid readings are given exactly as made, and are not reduced to any one standard. Hence they do not give absolute, but only relative, values. The Casella and Watkin aneroids are compensated for temperature, and a determination of their temperature coefficients made at Hamburg after the return of the expedition, shows that no correction is needed within the small range of temperature in the room in which they were placed. (See column 6, Tables I, IV, VII.) The Hottinger aneroid, however, has a large temperature coefficient, which was determined at Hamburg to be + 0.004 inch for each rise of 1° Fahr. The instrument has an attached thermometer graduated to each two degrees Fahr. Assuming 60° as the reference temperature, the readings have been corrected by the aid of the above coefficient. The original readings, temperatures and reduced temperatures are given in columns 2, 3 and 4, Tables II, V, and VIII.

The curves of the barograph record have been carefully read for the times of the observations with the other barometers.

They are given in millimetres and tenths in column 4, Tables I, IV, VII. The temperatures in column 5 of the same tables are those of the attached thermometer of the instrument. It will be seen that the temperature of the instrument was nearly constant during the observations. Its temperature coefficient was, therefore, not determined. A jump in the readings, designated by an asterisk, shows where the sheets were changed, and does not indicate a sudden change in the pressure.

The readings of all thermometers are given as made, except that the instrumental corrections have been applied. The black bulb thermometer of the Arago-Davy actinometer is constructed for a maximum thermometer with a detached portion of mercury. It was used for the current observations by reading the mercury column below the break, and correcting by the length of the detached portion and air bubble, which was carefully determined at various times and found to be constant.

The anemometer is of the Robinson pattern, similar to those in use by the U. S. Signal Service. The dial is graduated to miles and tenths. An extra reading of the dial was made five minutes after the regular time of reading on the 18th and 20th, in order to give the velocity in five minutes, for comparison with the similar observations on the 19th.

The programme for the total phase included observations of the shadow bands and of the solar corona, which were not made on account of clouds. A photographic camera, a $2\frac{1}{2}$ telescope, and several other instruments have not been included in the outfit named above, because they were not used in the observations.

TABLE I.

August 18, 1887. A. L. ROTCH, Observer.

Local Time.	Casella Bar.	Watkin Bar.	Barograph.		Ther. in Room.	Psychrometer.		Relative Humid'y.
			Scale.	Att. Ther.		Dry.	Wet.	
4.43	29.453	29.603				10 0	9.7	96
5.43	.460	.605	739.8	17.5		11.6	10.4	93
6.43	.460	.605	739.8	17.5	15.0	12.6	11.7	89
7.43	.452	.595	739.7	17.3	15.5	13.0	11.9	87
8.43	.442	.588	739.5	17.0	15.8	15.2	13.2	78
9.43	.437	.582	739.2*	17.2	16.2	16.1	13.7	75
10.43	.425	.570	739.0	17.3	18.0	18.8	14.8	80
11.43	.417	.558	738.7			19.3	15.1	61
12.43	.402	.545	738.2	18.0	19.2	20.5	15.0	59

*Sheet changed. Second sheet reads 0.4 lower than first.

TABLE II.

August 18, 1887. W. UPTON, Observer.

Local Time.	Hottinger Bar.			Conjugate Therms.			Bodien Black.	Earth Ther.
	Observ'd Reading.	Att. Ther.	Reduced Reading	Black.	White.	Diff.		
4.43								11.0
5.43				11.7	10.9	0.8	11.9	11.4
6.43	29 518	64	29.534	14.6	13.3	1.3	15.6	12.2
7.43	.537	59	.533	15.6	14.4	1.2	16.6	13.7
8.43	.525	60	.525	21.7	18.5	3.2	23.2	15.8
9.43	.510	64	.526	21.4	19.4	2.0	23.9	16.3
10.43	.494	65	.514	31.2	27.3	3.9	34.6	19.1
11.43	.477	66	.501	31.0	26.4	4.6	34.6	19.7
12.43				31.5	27.2	4.3	34.7	20.7

TABLE III.

August 18, 1887. W. KÖPPEN, W. UPTON, Observers.

Local Time.	Anem. Dial	Vel. in 5 Min.	Wind Direc.	Cloudiness.	Kind and Motion of Clouds.
4.43	541.7		S.S.E.	10	Cir. str.
5.43	545.1		S.S.E.	10	
5.48	545.4	0.3			Str. cum. from S.S.W.
6.43	549.2		S.S.E.	10	
6.48	545.7	0.5			
7.43	555.4		S.S.E.	10	Cir. str.
7.48	555.9	0.5			
8.43	561.2		S.S.E.	10	Str. cum. from S.W.—S.S.W.
8.48	561.8	0.6			
9.43	568.6		S.S.E.	9	
9.48	569.2	0.6			Cir. str.
10.43	576.9		S.	9	
10.48	577.9	1.0			Cum. from S.W.—S.S.W.
11.43	586.9		S.S.E.	9	
11.48	587.6	0.7			
12.43	596.4		S.S.E.		

TABLE IV.

August 19, 1887. A. L. ROTCH, Observer.

Local time.	Casella bar.	Watkin bar.	Barograph.		Ther. in room.	Psychrometer.		Relative Humid'y.
			Scale.	Att. Ther.		Dry.	Wet.	
4.13	29.212	29.355			18.5	13.5	13.2	96
4.43	.208	.354	733.2	18.5	17.2	13.6	13.4	98
5.13	.198	.342	3.1	18.3	16.5	13.9	13.6	96
5.33	.195	.342	2.9	18.2	16.5	13.8	13.6	98
5.38	.198	.342	2.9			14.0	13.7	96
5.43	.199	.345	3.0	18.2	16.5	14.0	13.7	96
5.48			3.1					
5.53	.199	.345	3.1	18.2	16.8	14.5	14.1	95
5.58	.198	.345	3.1	18.2	16.2	14.4	14.1	96
6.03	.198	.345	3.0			14.6	14.2	98
6.08	.195	.342	3.0	18.1	16.3	14.6	14.2	95
6.13	.197	.345	3.0			14.7	14.3	95
6.18	.200	.348	3 1	18.1	16.2	14.8	14.3	94
6.23	.198	.346	3.0			14.6	14.2	95
6.28	.196	.343	3.0	18.0	16.8	14.6	14.2	95
6.33	.195	.342	3.0			14.6	14.2	95
6.38	.199	.345	3.1			14.5	14.1	95
6.43	.198	.346	3.1	18.0	17.0	14.5	14.1	95
6.48	.202	.351	3.2	18.0	16.9	14.4	14.0	95
6.53	.202	.352	3.2			14.1	13.8	96

TABLE IV (*continued*).

August 19, 1887. A. L. ROTCH, Observer.

Local Time.	Casella bar.	Watkin bar.	Barograph.		Ther. in Room.	Psychrometer.		Relative Humid'y
			Scale	Att. Ther.		Dry.	Wet.	
7.08	.206	.352	3.2	17.9	16.5	12.9	13.0	100
7.13	.205	.352	3.2	17.9	16.1	13.0	13.0	100
7.18	.205	.352	3.2			13.1	13.1	100
7.23	.203	.350	3.2	17.9	16.1	13.1	13.1	100
7.28	.203	.351	3.2			13.4	13.4	100
7.33	.206	.352	3.1	17.9	16.8	14.1	14.0	99
7.38	.207	.353	3.2			14.4	14.2	98
7.43	.210	.358	3.2	17.9	17.0	14.4	14.1	96
7.48	.210	.358	3.2			14.5	14.2	96
7.53	.212	.358	3.2	17.9	16.3	14.8	14.4	95
7.58	.213	.358	3.2			15.0	14.6	95
8.03	.215	.362	3.3	17.9	17.0	15.1	14.5	93
8.08	.218	.362	3.3	*		15 2	14.5	92
8.13	.218	.362	3.7*	17.9	17.0	15.5	14.7	91
8.18	.218	.362	3.7			15.9	15.0	90
8.23	.215	.362	3.6	18.0	17.5	16.0	15.2	91
8.28	.213	.361	3.5			16.2	15.5	92
8.33	.215	.362	3.5	18.1	17.3	16.2	15.4	91
8.43	.216	.362	3.5			16.5	15.5	90
8.53	.218	.363	3.7	18.1	17.8	16.9	15.8	89
9.03	.213	.362	3.6			18.1	16.6	85
9.13	.215	.361	3.5	18.1	18.0	18.0	16.3	83
9.23	.215	.361	3.5			18.0	16.3	83
9.33	.212	.358	3.4	18.2	18.2	18.4	16.3	79
9.43	.212	.358	3.3			19.3	17.1	79
9.53	.212	.360	3.3	18.5	18.8	19.5	17.4	73
10.03	.210	.355	3.2			19.8	17.3	77
10.13	.213	.358	3.3	18.6	19.0	19.5	17.1	77
10.43	.212	.358	3.2	18.8	19.2	19.9	17.2	75
11.13	.225	.370	3.7	19.0	20.0	21.1	18.1	73
11.43	.226	.370	3.7	19.3	20.3	20.9	17.9	73

Notes.—The morning dawned cloudy (cum. with cir. streamers above), but rifts in the clouds gave some promise of an observation of the eclipse. The first contact was not seen, nor was the sun visible at any time except dimly through clouds. Darkness began to increase about 6:30, so that candles which had been used in the house until about 5 o'clock to read the barometers were again necessary.

At 6:56, took position in open field facing west, to observe diffraction bands. At 6:58, read radiation thermometers without difficulty. About this time the sun looked through the clouds as with a sort of yellowish corona, and a star (Regulus?) appeared about 10° north of it. The darkness rapidly increased until it was about equal to that one-half hour after sunset. The second-hand of a watch could easily be placed throughout totality. A candle under a table in the open air threw a radiance around. The color of the landscape was yellowish-green. The cattle began to low. In the southwest the horizon was of a brilliant orange, as after sunset. The darkness remained con-

* Sheet changed. Second sheet reads 0.3 higher than first. Max. temp. before totality, 14.9. Min. temp. during eclipse, 12.6°.

stant for a few moments. No shadows were seen to move over the ground before or after totality. Upon glancing at the sun a brilliant white spot was seen to appear on one limb. The darkness decreased and the landscape resumed its normal color.

Returned to house at 7:08, when candles were again used for the first observation of the barometers. Copious dew was noted to have fallen, which remained on the thermometers for nearly half an hour after totality.

TABLE V.

August 19, 1887. W. UPTON, Observer.

Local Time.	Hottinger Bar.			Conjugate Therms			Bodien Black.	Earth Ther.
	Observed Reading.	Att. Ther.	Reduced Reading.	Black.	White.	Diff.		
4.13	29.300	64	29.316					
4.43	.298	63	.310	13.8	13.8	0.0	13.7	13.9
5.13	.275	63	.287	14.5	13.9	0.6	14.9	14.0
5.33	.274	62	.282	14.7	14.0	0.7	15.5	14.0
5.38	.274	62	.282	14.6	14.0	0.6	15.4	14.0
5.43	.283	62	.291	14.8	14.2	0.6	15.5	14.0
5.48								
5.53	.286	62	.294	15.5	14.6	0.9	16.1	14.5
5.58	.288	62	.296	15.9	14.8	1.1	16.6	14.5
6.03	.280	62	.288	16.2	15.2	1.0	16.8	15.0
6.08				16.3	15.2	1.1	16.8	14.9
6.13	.278	62	.286	16.6	15.4	1.2	17.4	15.2
6.18	.282	62	.290	16.8	15.6	1.2	17.6	15.2
6.23	.292	62	.300	16.5	15.4	1.1	16.9	15.2
6.28	.285	63	.297	16.5	15.4	1.1	16.9	15.1
6.33	.288	63	.300	16.5	15.4	1.1	16.9	15.2
6.38	.293	63	.305	16.1	15.2	0.9	16.8	15.0
6.43	.290	63	.302	16.0	15.2	0.8	16.6	15.0
6.48	.294	63	.306	15.5	14.8	0.7	15.2	14.9
6.53	.294	63	.306	14.9	14.4	0.5	15.5	14.3
6.58				14.2*	14.0*	0.2*	14.6*	
7.03	.289	63	.301	13.6	13.4	0.2	13.6	13.7
7.08	.299	62	.307	13.5	13.3	0.2	13.6	13.5
7.13	.289	62	.297	14.0	13.4	0.6	14.5	13 5
7.18	.295	62	.303	14.4	13.5	0.9	14.9	13.6
7.23	.296	61	.300	16.2	14.4	1.8	17.1	13.9
7.28	.295	61	.299	18.7	16.5	2.2	20.5	14.0
7.33	.297	62	.305	21.4	17.8	3.6	23.7	14.7
7.38	.299	62	.307	21.7	18.2	3.5	24.1	15.0
7.43	.299	62	.307	19.2	17.2	2.0	21.4	15.0
7.48								
7.53	.296	62	.304	19.7	17.4	2.3	21.0	15.7
7.58	.297	62	.305	19.8	17.5	2.3	21.4	15.9
8.03	.299	63	.311	19.7	17.7	2.0	21.3	15.9
8.08	.298	63	.310	19.9	17.8	2.1	21.5	16.1
8.13	.302	63	.314	20.7	18.3	2.4	22.4	16.3
8.18	.298	63	.310	22.0	19.2	2.8	23.9	16.8
8.23	.290	63	.302	26.0	21.3	4.7	28.7	17.2
8.28	.289	64	.305	26.8	22.1	4.7	30.3	17.9
8.33	.291	64	.307	25.4	21.7	3.7	28.5	17 8
8.43	.295	65	.315	25.1	21.5	3.6	27.8	18.0
8 53	.295	66	.319	26.6	22.7	3.9	29.7	18.5
9.03	.279	67	.307	32.7	26.7	6.0	37.4	20.8
9.13	.271	69	.307	26.9	23.8	3.1	30.4	19.4
9 23	.267	69	.303	26.2	23.1	3.1	28.8	19.0
9.33	.263	69	.299				30.4	19,6
9.43	.264	70	.304	31.4	26.3	5.1	35.5	20.7
9.53	.257	71	.301	36.0	29.4	6.6	40.7	22.2
10.03	.252	72	.300	32.6	28.5	4.1	37.1	22.3
10.13	.245	73	.297	27.4	24.9	2.5	30.4	20.8
10.43	.262	71	.306	26.9	24.1	2.8	29.1	20.2
11.13	.277	71	.321	33.8	28.7	5.1	38.1	22.6
11.43	.267	72	.315	35.0	30.3	4.7	38.9	23.2

* Read by Mr. Rotch.

Notes.—While watching intently for the shadow and the bands, I saw once or twice at my left (S.E.) flashes of light like very faint lightning flashes, (time about 6:57 as recalled later); also at the expected time for the bands, saw pulsations which may have been the bands themselves or possibly falling dew. During the total phase I saw no defined shadow in the sky; the horizon between azimuth 200°–230° (S.S.W–S.W.) was bright orange. A clear patch of sky towards the west at altitude of about 45° was gray during the total phase. No other parts observed. It was not dark; one could easily read a watch face.

The sun was seen plainly several times in the second partial phase.

Copious dew began to fall at about the time of the beginning of totality, and continued long after its close. The radiation thermometers were wiped at 7:23, again at 7:43 and again at 8:18, more than an hour after totality and 13 minutes after the last contact.

Notes.—[The following notes are a translation of the original notes in German by Prof. Köppen.]

The sky on the 19th, from early morning was covered by clouds at varying heights, but with occasional rifts, in which cirrus filaments were almost always visible. The upper clouds were of the nature of feathery, filamentous or woolly cirri; the lower, which lay one above the other at different elevations, of small masses which before sunrise corresponded to small nimbi, later to strato-cumuli and after the eclipse principally to the alto-cumulus form (adopting the earlier nomenclature of Hildebrandsson). From fifteen to twelve minutes before totality, the clouds on the horizon, right and left beneath the sun, were of a faint orange color, and in the west their upper edges, two or three degrees above the horizon, were tinted with a faint red, but up to the time of totality there were scarcely any colors noted. At the above mentioned time, there existed between the whitish cloud bank in the south and the dark gray bank in the north, a streak of blue sky, which arose from S.W. or W.S.W., and at the beginning of totality extended from the west point beyond the zenith, with a width of perhaps 20°. The large, white, woolly

masses which formed the northern edge of the high cloud-bank above mentioned, appeared at this streak as a peculiar faint silver-white upon a dark blue (not dark gray) back-ground. This was nine minutes before totality. This southerly bank was composed in its principal portion of diffuse cirrus-filaments

TABLE VI.

August 19, 1887. W. KÖPPEN, W. UPTON, Observers.

Local Time.	Anem. Dial.	Vel. in 5 min.	Wind Direc.	Cloudiness.	Kind and Motion of Clouds.
4.13	722.3		S E.	8	Cir. str.
4.43	723.6		S E.	7	Nim. from W.
5.13	725.1		S.S E.	7	Cir. from W.S.W.
5.33	726.1		S.S.E.		
5.38	726.3	0.2	S.S.E.		Str. cum. from S.W—W.
5.43	726.5	0.2	S.S.E.	7	
5.48		0.2			
5.53	726.9	0.2	S.S E.	9	Str. cum.
5.58	727.2	0.3	S S.E.		About 6:40 there arose in S. a diffuse
6.03	727.5	0.3	S.S E.	9	cirrus bank diagonally striated N.N.E.—
6.08	727.8	0.3	S.S.E.		S. S. W., which vanished in E. about 7:30.
6.13	728.2	0.4	S. by E.	9	
6.18	728.6	0.4			
6.23	729.0	0.4	S. by E.	9	Str. cum. from S.
6.28	729.4	0.4	S. by W.		
6.33	729.6	0.2	S by W.	9	N.W. edge fleecy. Between this and a
6.38	729.9	0.3			dark bank in N. a broad patch of clear sky,
6.43	730.1	0.2	S. by W.	9	which during total phase, extended from
6.48	730.4	0.3	S.		W. beyond zenith. The bank in the N.
6.53	730.7	0.3	S.	7	sank, and about 7 18 was only 10° high.
6.58		0.3			
7.03	731.4	0.4	S.	7	
7.08	731.7	0.3	S.		
7.13	732.1	0.4	S by W.	6	
7.18	732.3	0.2	S. by W.		
7.23	732.5	0.2	S. by W.	5	
7.28	732.8	0.3	S.		
7.33	733.0	0.2	S. by W.	4	A few cirri.
7.38	733.2	0.2	S S.W		
7.43	733.7	0.5	S. by W.	7	Alto-cum.
7 48		0.4			
7.53	734.5	0.4	S. by W.	7	
7.58	735.0	0.5	S. by W.		
8.03	735.5	0.5	S.S W.	8	
8.08	736.1	0.6	S.S.W.		Alto-cum. from S W.
8.13	736.5	0.4	S. by W.	7	Lower scud from S.W. to S.
8.18	736.9	0.4	S S.W.		
8.23	737.3	0.4	S S.W.	7	Cir.
8.28	737.6	0.3	S S W.		
8.33	738 0	0.4	S. by W.	6	Alto-cum. from S.W.
8.43	738.8		S.S.W.	6	Lower scud.
8.53	739.4		S.W.	6	
9.03	740.1		S.W.	6	Large fleecy cirri, V point in W.
9.13	741.1		S.S.W.	8	
9.23	742.1		S.W. by S	8	Alto-cum. from S.W. to S.S.W. and S.
9.33	743.0		S W. by W.	9	
9.43	743.9		S.S.W.	9	Cir.
9.53	744.7		S.S.W.	10	Alto-cum.
10.03	745.4		S W.	10	Soft cum. from S.W. to S.
10.13	746.6		S.W.	10	Soft cum. from S.S.W. increasing. [above.
10.43	749.9		S.W.	10	" " " " " High cir. str. sheet
11.13	753.3		S.S.E.	8	Cir. str. sheet disappearing in N.E.
					Cir.
					Cum from S.S.W.
11.43	756.9		W.S.W.	6	Cir. cum. from S W. to W.S W.
					Cum. from S.W.

inclined to its longer dimension, the striæ lying in the direction N.N.E.–S.S.W., which at its edge took on the appearance of the woolly alto-cumulus, the leading characteristic of the clouds on this day. The bank moved between 6:40 and 7:30 A. M. from the S. or S.W. point towards the E. point of the horizon. Its color was brownish-white. The similar coarse woolly cirrus, which at the streak of blue sky formed the southern edge of the thicker bank at the north, was dark gray, like the bank itself. Two or three minutes before totality the color of the sky in the west horizon, in the lower part of the rift, was a bright green under a gray cloud streak. At about this time there occurred two or three times momentary flashes of light (Aufblinken) in the general day-light, of the appearance of distant lightning which one sees without directly looking at it.

At the approach of the shadow, suddenly the clouds in the S. W. were veiled in a very dark gray, which completely concealed their outlines, and extended into the blue rift. But here, at an azimuth of about S. 60° W., a distinct boundary line was formed by a faint whitish brightness which filled the right side of the rift, diminishing towards the right, and contrasted with the gray in the S.W. on its left border, like a vertical streak of light. This brightness was displaced by the rapid widening of the shadow towards the right or north, but there remained during totality, above the sinking dark cloud-wall in the north, a bright border, somewhat like the reflection on the silver clouds in a June evening of the last year above the dark lower clouds. At the east and south moreover, the horizon to a height of 2° or 3° was bordered by a bright streak of brilliant orange. No colors were anywhere noted in the west. The surprisingly quick brightening occurred between S.W. and W.S.W. just as the darkening, and shadow bands were seen, but these I did not carefully observe. During the minutes of totality my attention was confined to the phenomena in the west and I did not observe the east, but eight minutes before, the thin clouds about the sun appeared like a brownish (not whitish) smoke, with a tinge of violet, somewhat as smoke-topaz. Somewhat later, as noted by Mrs. Olga Kisseleff, the clouds at the height of the sun became

red, as if from the reflection of a fire, and this red extended downward, merging itself in the orange at the horizon. The blue sky in the zenith between the bluish white clouds appeared also during totality of a dark blue, like the corn-flower, according to the observation of Mr. Grigorjeff, director of the realschule in Iwanowo, who describes it as a specially striking phenomenon.

After totality the clouds were of a predominating alto-cumulus character, as before. The northern cloud-bank sank lower and one-quarter of an hour after totality was only about 10° in altitude. The sky partly cleared (4 on a scale of 10) and the sun came out. Above two distinct layers of alto-cumulus appeared again cirri; beneath were soft cumuli, at about 9:30 A. M. The motion of all clouds, as far as I could determine, was from the S.W. and remained unchanged. Forty minutes after totality, the clouds on the horizon to a height of 2° or 3° under the sun were tinged with a bright orange. No other colors were noted.

TABLE VII.

August 20, 1887. A. L. ROTCH, Observer.

Local time.	Casella bar.	Watkin bar.	Barograph.		Ther. in room.	Psychrometer.		Relative Humid'y.
			Scale.	Att. Ther.		Dry.	Wet.	
4.13	29.108	29.252			19.0	15.0	14.7	97
4.43	.083	.228	730.2	19.9	18.2	15.1	14.7	96
5.43	.070	.213	729.9	19.8	18.8	15.2	14.7	94
6.43	.062	.208	9.8	19.6	18.8	16.8	15.5	86
7.43	.055	.202	9.7	19.5	18.5	17.0	15.7	87
8.43	.052	.198	9.2*	19.8	19.0	18.5	16.1	77
9.43	.060	.205	9.6	19.8	19 2	18.5	16.4	79
10.43	.068	.215	9.7	19.8	20.0	20.0	17.8	80
11.43	.070	.212	9.8	20.1	20.8	21.7	18.2	70

*Sheet changed. Second sheet reads 0.2 lower than first.

TABLE VIII.

August 20, 1887. W. UPTON, Observer.

Local time.	Hottinger Bar.			Conjugate Therms.			Bodien Black.	Earth Ther.
	Observed Reading.	Att. Ther.	Reduced Reading.	Black.	White.	Diff.		
4.13	29.172	66	29.196					
4.43	.150	66	.174				15.6	15.2
5.43	.136	66	.160	19.0	16.9	2.1	20.9	15.0
6.43	.134	66	.158	27.2	22.8	4.4	31.6	16.5
7.43	.117	66	.141	23.2	20.2	3.0	24.7	16.9
8.43	.114	67	.142	22.9	21.3	1.6	24.5	17.6
9 43	.117	68	.149	22.7	20.8	1.9	23.9	18.0
10.43	.114	67	.142	31.2	25.1	6.1	32.8	20.0
11.43	.122	68	.154	34.0	28.4	5.6	35.7	21.2

TABLE IX.

August 20, 1887. W. UPTON, Observer.

Local time.	Anem. Dial.	Vel. in 5 Min.	Wind Direc.	Cloudiness.	Kind and Motion of Clouds.
4.13	871.6		E.S.E.	8	Cum. from S.-S.W., heavy in N.W.
4.18	872.6	1.0			
4.43	878.0		E.S.E.	6	" " " " " "
4.48	879.1	1.1			
5.43	889.5		E.S.E.	4	" " " " " " S.W. and N.E.
5.48	890.3	0.8			
6.43	902.0		E.S.E.	6	" " " Upper cirri from N.E.
6.48	903.1	1.1			
7.43	914.3		S.E.	9	" " " heavy in N.E.
7.48	915.2	0.9			
8.43	927.4		S.S.E.	9	" " " " " " N. and S.E.
8.48	928.4	1.0			
9.43	939.5		S.E.	10	" " " " " " N. and S.
9.48	940.5	1.0			
10.43	949.8		S.E.	9	" " " " " " S.W.
10.48	950.8	1.0			
11.43	962.2		S.S.E.	9	" " " Several light showers between 7:43 and 10:43.
11.48	963.4	1.2			

WINSLOW UPTON.
A. LAWRENCE ROTCH.

[TO BE CONCLUDED.]

IS THE RAIN-FALL INCREASING ON THE PLAINS?

An increase of annual rain-fall on the western plains would be of the highest importance, as it would increase the agricultural capacity of a large territory, and would thus not only add to the wealth of individuals who have taken land there, but to that of the entire nation. The subject has naturally received much attention, and the conclusions drawn have been various, some in favor of the suspected increase, others opposed. Recently public attention has been again called to the matter in a speech of General Morrow, an article by ex-Senator Dorsey, and a public letter by the eminent president of the Union Pacific railroad, Mr. Charles Francis Adams. Mr. Dorsey's article appeared in the *North American Review*, and opposed the view that the rain-fall is increasing, while Mr. Adams, in a letter to the *Nation*, and General Morrow, in his speech, favored this view. Professor S. R. Thompson, then director of the Nebraska State Weather Service, discussed the problem in 1884 in this JOURNAL (Vol. I, p. 56), and came to the conclusion that, so far as his State was concerned, the question was still in doubt, though the

incomplete answers then obtainable rather favored the view that the rain-fall was increasing.

The question of increase or decrease of annual rain-fall is a difficult one to decide for any locality. The precipitation in the temperate zone is extremely variable from season to season, and the annual amounts show very great differences, even for successive years. The total amount of rain-fall for one locality for a year is not so large but that a single heavy thunder-storm or a long steady rain may make a marked difference in the total, the effect of which, on the average, can only be eliminated by a long series of years. Thus of two stations, not very far apart, one may show for many years an apparent average rain-fall higher than that of the other, due to one single thunder-storm which passed over the one and not over the other.

Moreover, while the rain-fall is very fluctuating, there are some especial difficulties in measuring it. The snow must be melted to find its equivalent in rain, but the snow drifts, and it is often impracticable to tell just how much snow did fall. Again the exposure of the rain-gauge may play a very important part in the amount of rain collected. So important is it that an apparent change of a fifth or a quarter in the rain collected may follow such changes in the position of the gauge as a careless observer might easily make in a five-acre lot, more or less occupied by buildings and trees.

In order to come to a definite conclusion as to change of rain-fall over the plains, we must have a long series of observations at our disposal, and they must be from a large number of stations. The limits of one state or territory, or of one or even half a dozen years, are too small. In order to utilize the largest number of observations possible, and at as widely different dates as possible, it has occurred to me that the maps of Mr. Lorin Blodgett, in his "Climatology of the United States," might be compared with some of the later results. Mr. Blodgett's book had a deservedly high reputation in its day. That it has latterly dropped out of sight is probably due in part to the fact that it is now old (it was published in 1857), but more to the fact that the attention of working meteorologists has been

for many years turned rather to the dynamical than to the statical side of the science. Mr. Blodgett was an acknowledged student of eminence in his day, and had access to all available observations, which, for the plains, were, for the most part, the observations at the various military posts.

For the later maps, I have chosen those of Dr. Charles Denison, of Denver. They were compiled from the observations of the Signal Service and received the official recognition of General Hazen. It is, perhaps, to the advantage of this comparison that the two authorities employed made use of entirely different series of observations, and that, in constructing their charts, they were entirely unbiased as to any comparative conclusion that could be drawn from them. Mr. Blodgett's data included all he could find up to 1855, and occasionally extended through that year and into 1856. They may perhaps be considered as representing the average condition at the epoch of 1850. Dr. Denison's are those of the Signal Service. The earliest are for 1870, the most of them several years later, and they end with with the end of the year 1883. They may be considered as belonging to an average, with the epoch at 1880. The two maps, therefore, represent as well as was practicable at the time they were made, the one the observations at the military posts, the other those of the Signal Service at two periods about 30 years apart.

To compare the maps, the simplest proceeding is to take some line of equal rain-fall in the one and see if it occupies the same position in the other. If there has been an increase of rain-fall the line of 20 inches, for instance, should have travelled westward in the interval between the two epochs. Dr. Denison gives such limiting lines, but Mr. Blodgett gives rather areas in which the number given is the average value. To get the corresponding line on Blodgett's map, I have interpolated from the areas given by him, assuming that, for instance, when the line of 20 inches will cross a parallel can be determined from where the limits of its area cross this parallel. Usually I have taken the point midway—always, in fact, unless I have seen reason to suspect an acceleration in the change from one limit

to the other. For the purposes of comparison I have taken the longitudes west of Greenwich of the points where the lines of equal rain-fall cross the northern boundary, and the latitudes of 45°, 40°, 35°, and 30°.

I have made use only of the lines of equal rain-fall which are on or immediately east of the plains. Those on the western boundary are too uncertain to be useful. And I have selected only those parts of these lines which are approximately perpendicular to the parallels. To the north, in the vicinity of the Great Lakes, they turn eastward and run nearly with the parallels. Here their crossing would not be instructive.

The results of the comparison are given in the following table. In the columns B are the longitudes of the crossings from Mr. Blodgett's map; in those headed D, those from Dr. Denison's. In the columns "Gain" are given the result of subtracting the figures in columns D from those in B. The positive sign means that the line of equal rain-fall has apparently travelled so many degrees westward; the negative, that it has apparently withdrawn eastward. The degrees can be turned into miles, with sufficient accuracy, by multiplying them by 55.

APPARENT ADVANCE OF LINES OF EQUAL RAIN-FALL TOWARD THE PLAINS.

	20 Inches.			25 Inches.			30 Inches.			35 Inches.		
	B.	D.	Gain.	B.	D.	Gain.	B.	D.	Gain.	B.	D.	Gain.
Northern Border	.....	.....	.....	96.0	92.7	−3.3	.....	.....	.....	.....	.....	.....
Latitude 45°	98.1	100.6	+2.5	94.8	98.3	+4.5	.....	.....	.....	.....	.....	.....
Latitude 40°	99.2	100.4	+1.2	97.8	98.6	+0.8	94.1	97.2	+3.1	93.1	96.0	+2.9
Latitude 35°	100.2	100.6	+0.4	99.1	99.1	0.0	97.5	98.3	+0.8	96.4	96.8	+0.4
Latitude 30°	100.9	100.9	0.0	99.7	99.0	−0.7	98.8	98.1	−0.7	97.0	97.2	+0.2

An examination of these figures shows an apparent advance along the zone included between the parallels 35° and 45°, and a regression above and below these latitudes. The latter is not so significant, for it occurs at the ends of the lines, where the map-maker was left more to his own fancy as to where he should put them. The latitudes 35° and 45°, however, are in the center of the map, and are as definite as the observations could make

them. The advance here is along the line of greatest flow of emigration into the plains; it is greatest at the north, where the earlier settlement occurred (in Iowa and Minnesota), where the lines have advanced something like 1° for every ten years, or about 5 miles a year. Farther south the advance has been much more slow, averaging, on the parallel of 35°, only 0.4°, or 22 miles, in the 30 years, making less than one mile a year.

That this apparent change is real seems highly probable, as it is in accordance with what might have been expected, and the results are very consistent in themselves. Some idea of what confidence can be put in such conclusions can be got by comparing in the two maps other and better known parts of the United States. As is to be expected, they show many variations. These are the most marked in the far west and near the borders of the maps. In the first case these are confessedly due to incomplete statistics, especially in the case of Mr. Blodgett's maps; in the second they are not so significant, as the map-maker has less to guide him at the edge of the maps, and the lines are there somewhat arbitrary. In the interior of the maps, east of the Mississippi, they are fairly consistent, and show little sign of a change over a large area. The apparent changes are there so small and vary so much from point to point as to convince one of their accidental character, and leave unshaken his confidence in the consistent advance of the lines of equal precipitation toward the plains. MARK W. HARRINGTON.

LOCAL WEATHER PREDICTIONS.

An article on this subject has already appeared in this journal, Feb. 1887, page 454, and as it is being quoted in foreign journals and elsewhere, it may be well to present a few general ideas on this question. The local predictions referred to in the above article were made by Mr. Clayton, at the Blue Hill Observatory, near Boston, Mass. It should be understood that these are not strictly local predictions as commonly understood, but they are based upon general weather charts, issued by the Signal Service, supplemented by a scrutiny of the local weather at the time of

the prediction, or sunset. Comparisons were also instituted between these predictions and those of the Signal Officer made at a different hour and for a large region covering the interior as well as the coast of New England. One or two points should be noted. It is well known that sunset is a very favorable time for local predictions of weather. At one time an observer in New York City, month after month, made predictions of rain amounting to .01 or none, and obtained an average of over 90 per cent. Then again a prediction for the Atlantic coast would be very different from one for the whole of New England, as one would very quickly learn on studying the weather. It would seem hardly possible to compare two such dissimilar quantities.

Since May, 1887, Mr. Clayton has been publishing in the Bulletin of the N. E. Met. Soc., results of local predictions of temperature and weather made by himself at Blue Hill Observatory, and comparisons between these and those of the U. S. Signal Service made almost invariably for the whole of New England. These comparisons have interested me very much, and I have had occasion to investigate some of the methods adopted. Mr. Clayton makes his predictions at 2 P. M. with the assistance of the map issued by the Signal Service from observations made at 7 A. M. The prediction is made for the 24 hours from the following midnight, and is compared with the Signal Office prediction made at 10 A. M. for the interval from 3 P. M. to 3 P. M. Laying aside for the present the possibility of comparing two such dissimilar predictions, I desire just now to examine Mr. Clayton's method of making and verifying temperature predictions. These predictions are published each afternoon in the *Boston Transcript*, and it is understood that if no temperature prediction is made the change in mean temperature will be less than 5° above or below the mean for the previous 24 hours. A prediction of "warmer" or "cooler" means that a mean temperature 5 to 10 degrees higher or lower than the previous 24 hours is expected, and "decidedly higher" or "lower" indicates in like manner a change greater than 10 degrees.

If we examine this system we are struck at the outset at the prediction for stationary temperature. In order to learn what a child or a totally ignorant person might accomplish on this system of prediction, I considered the result of a prediction "stationary" for every day in the month, with the following interesting result:

COMPARISON OF RESULTS OF PREDICTIONS BY MR. CLAYTON AND ONE OF "STATIONARY."

	1887.						
	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
	%	%	%	%	%	%	%
Mr. Clayton.....	50	63	71	71	70	54	63
Stationary.....	58	63	74	84	70	68	69

This surprising result seems to indicate that the skill in predictions and the assistance acquired from the daily maps are really hindrances, and one would be much better off to predict, as the Almanac maker does, for 100 years in advance.

We find the same thing true, though in less degree, of the prediction for "weather." Leaving out of the account the prediction of "threatening," which when properly interpreted tends to increase the percentage, let us take the simple predictions of "fair" or "rain." It is plain that what the public most desires to know is whether it is going to rain or not, and, more than this, the term "threatening" has a peculiar significance of its own impossible to be verified by simple records of cloudiness. Let us consider that for "rain" there must be at least .01 or the smallest measurable amount, and let a child make the prediction "fair" for every day, the result for the months above would be as in the subjoined table:

COMPARISON OF VERIFICATION OF WEATHER PREDICTIONS.

	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
	%	%	%	%	%	%	%
Mr. Clayton.....							
"Weather".....	77	87	74	71	70	67	74
Child.....							
"Fair".....	77	83	65	71	77	77	75

Here we have relatively the same result as before. An ignor-

amus would get a better percentage than an able man with the aid of all the charts and skill he could command.

It is a matter of congratulation that this subject of predictions is attracting so much attention just now. It is a little surprising that the practice should be so different in different countries. Care should be exercised, in making comparisons, that similar things are compared. The wording and method of prediction should have as little of guess-work as is possible. For such a variable climate as New England, with weather changes coming suddenly from Canada, where we have no observations at a distance, a high percentage can never be expected; but for regions farther south we may hope for a gradual improvement in the percentage of verification. There should be the fullest discussion, by those understanding the situation, as to what the public really desire and how this desire may be best subserved in predictions and their verification. If such predictions and comparisons as these of Mr. Clayton lead to greater light and better understanding of the conditions involved in weather forecasts, they will be of great and lasting benefit.

GAN.

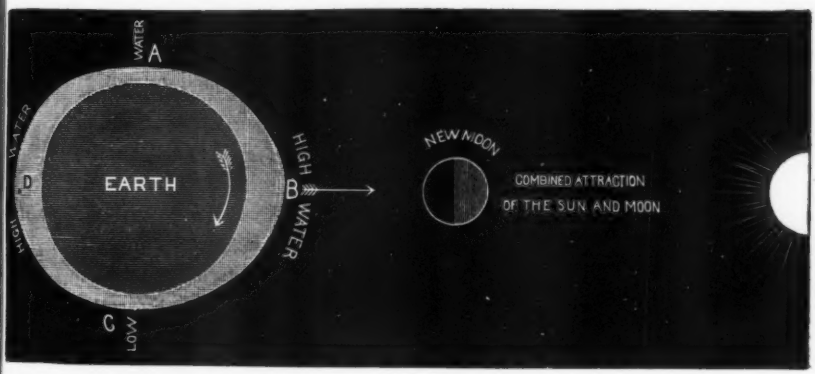
November 7, 1887.

THE TIDES.

To those familiar with the standard text-books on astronomy and to the readers of the various scientific journals of the day, it is a fact well known that a satisfactory solution of the causes of the tides is yet the subject, to say the least, of much doubt and continued research. Such being the case, no apology is deemed necessary for the following. On the next page I introduce a cut taken from Guillemin's "Heavens." I have only added A, B, C and D, as points of reference.

The earth is rotating from A to B. B is one point of high water, while the opposite, D, is another. Now as to the cause. By the combined attractions of the sun and moon acting on the waters of the globe, —which are free to move regardless of the earth's motion,—the waters lying between A and B are *accelerated.* Those lying between B and C are *retarded,* or, in other

words, the waters between A and B move more rapidly than the rotation of the solid body beneath them. From B to C they are held back, and move more slowly, thus piling up at B, forming the tide directly under the sun and moon. For the cause of the tide at D we must here refer you to a description of the earth where it is supposed to be free from extraneous influences. I quote from Guillemin's "Heavens": * * * "The earth, having the form of a spheroid, the liquid stratum which covers it would have a form exactly similiar, and continually the same, if the sun and moon did not exist." * * * Now allow these influences to enter the problem, *i. e.*, the attractions of the sun and moon. Normal conditions of the waters no longer exist, except on cer-



tain points of the globe at certain times. That is to say, with regard to the depth of the waters, they will be abnormal,—less or greater,—at high and low tide, and normal at some place between these two points. At the point D the waters are in an abnormal condition on account of the greater amount of gravity being exerted upon them at this point. They are here acted upon by the attraction of *three* bodies, the sun, moon and earth acting in conjunction. Now, if gravity forms the stratum of water to fit the rotundity of the earth where that force is in operation in an abnormal degree, at that point the waters will pile up higher than elsewhere. We find this point at D. To illustrate: if we had a fluid substance that a magnet would at-

tract, and were to fill a shallow vessel—say a dinner plate—with it; now hold a magnet under the plate, and the substance would have a greater depth immediately over the magnet than elsewhere.

GEO. W. TINSLEY.

COLUMBUS, IND., Nov. 7 1887.

SELECTION.

TIERRA DEL FUEGO.

[CONTINUED].

For a number of years the Chilians have been washing gold at the foot of the chain of hills which forms the coasts of Useless and Future Bays. Señor Fredrico Mourglier, who has had much personal experience in the country, says that "the existence of gold on the eastern coast is undoubted, and only requires labor to separate it from the sands; while the northern part of Tierra del Fuego requires a practical exploration to disclose its richness." A well known English gentleman, who now resides in Córdoba, as the head of a commercial house, who was wrecked off States Island several years ago, and lived for some weeks at Good Success Bay, the extreme eastern point of Tierra del Fuego, makes the statement that he "found gold there, the rocks on the coast all being impregnated with the shining ore." Señor Felix M. Paz, the governor of Tierra del Fuego, in a communication to his Government gives an interesting account of a visit to San Sebastian Bay and of the auriferous nature of the sands at that point. He says: "The specimens we obtained are fine, very black, and when washed in a very primitive fashion we obtained leaflets of pure gold, twenty of which went to the gram." He proposes a scientific exploration of those regions, and is satisfied that "there are there the elements of a new industry which will metamorphose that desolate land." Since then other parties have visited San Sebastian Bay and fully confirm what the governor states on this subject. Indeed, judging from the formation and from the reports of various persons who have prospected there, it is believed that gold abounds along the whole extent of the Onisin chain to the Straits of Magellan and the Atlantic Ocean, and from Useless

Bay to that of San Sebastian. In all that country water-courses abound, and wood in great quantities is found for fuel, thus assisting in the mineral development of that portion of the country.

The meteorology of Tierra del Fuego is yet to be studied. The climate is certainly not the best in the world, by a great deal, but it is not as bad as it has been painted. Thus far, each voyager to that country has hastened to give us his impressions from his own stand-point, only imperfectly guessed at after a few days' sojourn. These are generally unfavorable, but I have conversed with ship-masters and passengers who have time and again steamed through the straits, and they have spoken of the delightful weather which they experienced during the entire passage. Of course, in this matter very much depends on the season; and there is no doubt that in the southern portion during the six months of winter, or what goes for winter, there is considerable wind and sleet and snow. But, after all, the thermometer proves that the weather is not so cold as it is in some of our Northern States. It is not strange that those whose systems have been relaxed by the very temperate, if not semi-tropical, climate of the Argentine Republic, should exaggerate the cold of Tierra del Fuego, since they are in a condition to suffer much more from it than those who are accustomed to a climate like that of Maine. At the same time, in a country extending through so many degrees north and south and with a surface so varied, there must be naturally considerable diversity of climate. Mr. Brydges tells us that in the humid regions of Western Tierra del Fuego frosts are almost unknown, while in the central and eastern parts, where the sky is nearly always cloudless, there are four months—June, July, August, and September—during which the cold is quite severe. Owing to the mountains in the north the climate is comparatively dry, while along the southern coast it is much of the time very humid and very cloudy. While in the former region the cold of winter is much severer than in the latter, yet in the summer the mean temperature is much higher. Mr. Brydges adds that the want of sufficient heat in summer is the great drawback to the climate of Southern Tierra del Fuego, a greater inconvenience, indeed, than the cold during

the winter, which has never been known to descend lower than 12° Fahrenheit, while the highest summer temperature only reaches to 75°. He says that the climate in that part of the country does not appear to be uniform, differing very greatly in different years, and the variations of a single day are often very remarkable. In Ushvia,* Beagle Channel, where he resides, destructive frosts have been known to occur during almost every month of the year, and occasional snow-storms have been experienced even in January, which is the very middle of summer; so that in that portion of the country all but the hardier vegetables are an uncertain crop. The grasses, however, are sufficient to carry the horned cattle and goats through the winter, though they sometimes become very poor from insufficient food. On the coasts in the vicinity of Sandy Point the summers quite correspond to those of our own Northern and Northwestern States, affording many warm days of uninterrupted sunshine. Indeed, in all the northern portion, under a much higher temperature, the various grasses grow very luxuriantly, and potatoes, beans, peas, and generally all the common vegetables reach to great perfection. A gentleman who was for some time in the vicinity of Useless Bay during the month of November, which about corresponds to our month of April, informs me that the range of the mercury was from 40° to 65° Fahrenheit. Indeed, if it were not for the winds, which are exceedingly prevalent in all parts of the country, the climate of Tierra del Fuego would be much more moderate than that of Canada. We all know, however, that raw, damp winds are much better conductors of cold than dry weather at a far lower temperature.

The nature of the vegetation of Tierra del Fuego has already been incidentally referred to. In all the pampa or prairie region there is a great abundance of sweet grasses, of several varieties, the moist climate assisting them to a growth which is in some places exceedingly rank. There are also numerous fruit-producing shrubs and vines. Mr. Brydges informs us that wild strawberries, wild raspberries, wild gooseberries, and wild grapes grow spontaneously all over the country and attain to an im-

* Mr. Brydges spells the name *Ooshvia*, while the Argentines write it as above.

mense size. Besides the ordinary vegetables which I have heretofore mentioned, the natives also cultivate celery and mushrooms. Among the edible plants is a great variety of parasitic *fungi*, indigenous to the country, which generally depend from the trunks of the trees—sometimes growing to be immense masses. Their internal structure presents a series of orifices, which are filled with sweet juices and which the natives are very fond of as an article of food. The kinds which grow in summer are dried and smoked for future use. Those which mature in winter are very similar in appearance, but have a different aroma. Nearly all the woody plants exude a gummy substance, which, after being boiled and sweetened, is very pleasant to the taste. It is thought that, with the development of the country, this gum may come to possess considerable commercial value.

The forests, which extend over a large portion of the country, are quite limited in variety. They contain but five kinds of trees, three of which are species of the beech, and the other two are winter-bark, which resembles the magnolia, and a species of cypress, quite peculiar to the country. Of the beech the most valuable variety is the evergreen, which produces magnificent timber with a diameter of six feet and an altitude of 80.* The common beech grows to almost equal proportions; while the third species, which is called aromatic, is much smaller, but produces a better wood for planking. The timber of the winter-bark, as also that of the cypress, is of little use on account of its small size. The latter, however, is represented to be a most beautiful tree and one of the peculiar charms of the country. There are twenty-five varieties of shrubs or arborets. One variety, called the hardwood (*leña dura*), with an evergreen leaf, abounds in all parts of the country. The leaf furnishes a most excellent article of food for the cattle and guanacos, while the wood is valuable on account of its fine grain, which admits of a polish like marble. Where the sub-soil is rocky or full of pebbles the vegetation is sterile; where it is sandy or of clay, the country is covered with grasses, among which are found the tussock, the wild oat, and the ganga. Owing to the rankness of

*Ship-loads of this timber now find a market in Buenos Ayres.

the vegetation, which year after year has accumulated upon itself, in some parts the surface is covered with a thick bed of swampy peat, which yields to the feet.

While there are probably few streams in the country which are of sufficient size ever to be utilized for navigation, there is a large number of small rivers and water-courses, which carry off the rains and melting snows from the mountains, and thus assist to irrigate the lower plains. Two of the most important of these are the Rio Rosetti and Rio del Oro (Gold River), which have their sources in the northern chain of sierras, and, after coursing through deep cañons and precipitous bluffs, empty into Lomas Bay, in the Straits of Magellan. Farther to the westward is a number of creeks, which find their outlets, respectively, in Phillip's, People's, and Future Bays. Emptying into Useless Bay is the St. Mary's River, which flows southward, also from the northern sierras, along the Balmaceda range, in a remarkably tortuous channel, with immense bluffs on either side. At the southern extremity of that bay are also found the Morazza River and a number of large arroyos which drain the high lands to the eastward. On the Atlantic coast are the Cullen River and the St. Martin River, both considerable streams, the first having its outlet south of Cape Holy Ghost, and the second in San Sebastian Bay.† South of this is the Toldo River ("Rio de los Toldos"), which runs in a very crooked channel into the Atlantic. According to Mr. Lista it has a breadth of 40 to 75 feet, a rocky bottom, and a current of two to four miles per hour. Then comes the Rio Pelegrini, named by Mr. Lista for the present vice-president of the Republic, which he says is the most important river in Tierra del Fuego. It is supposed to rise in the central Cordilleras of the country. Mr. Lista found great difficulty in crossing it on account of its depth and current. Its breadth is from 225 to 300 feet, with frequent small islands along its channel. Its depth is from 6 to 10 feet. It flows through

†The names of all the foregoing rivers are those which Mr. Popper has assumed to give them, and they may yet be changed. The names of the rest of the rivers are those which Mr. Ramon Lista has given them, and they likewise are liable ultimately to be changed by the Argentine Government. In none of the maps of Tierra del Fuego hitherto published does it appear that there are any rivers in that country.

an alluvial valley, whose vegetable richness is marvelous and capable of sustaining a large pastoral industry. The bed of the stream is somewhat irregular, and the explorer everywhere saw indications of the great floods which annually, on the breaking up of winter, come down from the mountains, bringing with them an immense amount of *detritus*. The current is about five miles an hour. Mr. Lista says: "I am of the opinion that it can be navigated by small steamers for many miles into the interior." Near Cape St. Agnes is another small river, which Mr. Lista has named the Rio Twelfth of September, which flows down a deep cañon, with dense forests of immensely high beech trees on each side. Near Cape St. Paul is likewise a small river, which has its source in the high lands of the interior. It is about 50 feet wide, with a very rapid current. There is abundant vegetation along its banks, while at its mouth are visible great quantities of masts and spars, the remains of ancient wrecks. Mr. Lista has given it the name of Rio Roca, from the late President of this Republic. Between this and Cape St. Vincent are several other small rivers, generally with high bluffs on each bank, and very rapid currents. The most considerable of these he has named Rio Lista, after himself. Along a part of this stream is a rich valley, with most luxuriant grasses and fine timber. On the southern side of Tierra del Fuego there are no rivers, if we except a small stream which empties into Slogget's Bay, and another which empties into the Bay of Yandagaya "a splendid bay, which reminds one of the fiords of Norway."

Of the animals native to the country the most important is the guanaco, found only in Onisin and the Island of Navarino, the large fox (*stenomys*), and two species of ground-rats or moles. Of the amphibious animals there are two species of seal and two species of otter (*nutria*). Whales and various kinds of excellent fish abound along the coast and in the different channels. The rivers also contain fish. Mr. Brydges informs us that there are ninety kinds of birds, five of wild geese, four of ducks, and two of swans, besides the albatross, the penguin, the cormorant, the woodcock, the partridge, the pigeon, the snipe, and other species of smaller size. The fish-king, the parrot, and the bee-

martin also abound. The condor is sometimes seen, and there are two kinds of eagles, etc. There is not a great variety of insects. There are various mollusks, one species of which, called "danawa" by the natives, is most delicious food, though one portion of it is said to be extremely poisonous. There are no snakes or reptiles in the country, and no beasts of prey. The dogs of the country are of a peculiar shaggy breed, but fleet and very strong; and to the people, in the protection of their huts and in the pursuit of game, are quite invaluable. Other domestic animals, such as horses, horned cattle, goats, cats, and all varieties of the feathered tribe, do well and readily accustom themselves to the change of domicile.

In regard to the natives of Tierra del Fuego, there have been so many contradictory statements made by various visitors to different parts of the country, that it is somewhat difficult to reconcile them. By some they are reported to be large, stalwart, and fine-looking men. By others they are said to be physically small and the most abject of human beings. Darwin, whose scientific investigations were confined principally to the southern portions of the country, states that "one can hardly believe them to be fellow-creatures and inhabitants of the same world," and he seems to have formed his idea of the "connecting link" from what he saw of them.* On the other hand, Señor Fredriço Mouglier, whose explorations were in the northern and northwestern parts of the island, informs us that "the Fuegians are powerful men of large stature and warlike instincts, living by the fruits of the chase, and having a kind of military organization under the command of one chief." Lieutenant Bové gives an equally favorable estimate of their appearance; while Captain Parker assures us that "they are beautiful specimens of the human race."

[CONCLUDED NEXT MONTH.]

* Mr. Popper says in the National Library at Paris there is preserved a curious publication, consisting of a map entitled "*Tabula geogaphica regni Chile.*" It was designed in the seventeenth century by the Jesuit fathers of that country, and exhibits in different parts of Patagonia drawings of Indians, of guanacos and of ostriches; whereas over Tierra del Fuego is painted the figure of an Indian in the position of one hurling an arrow. The most remarkable thing in this drawing is that the hind part of the Indian is adorned with a strange prolongation of the backbone, with this inscription attached, "*Caudati homines hic*" ("Here are men with tails"); evidently the connecting link which Mr. Darwin was in search of in order to prove his theory.

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